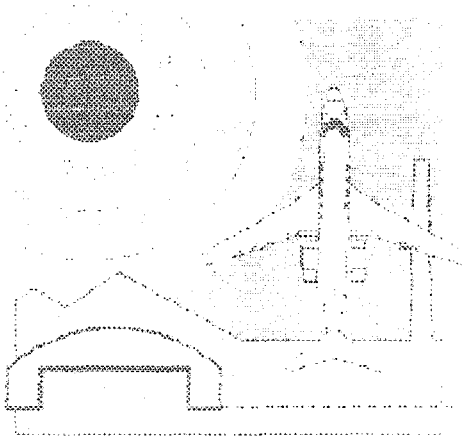
SECTION 7: ALTERNATIVES ANALYSIS



BISBEE-DOUGLAS INTERNATIONAL AIRPORT
Douglas / Cochise County, Arizona

AIRPORT MASTER PLAN - 1997

SECTION 7:
ALTERNATIVES ANALYSIS

INTRODUCTION

This section contains a detailed comparative evaluation of six (6) alternate runway development options for the Bisbee-Douglas International Airport.

The comparative evaluation was approached from a purely analytical point of view, comparing several areas of potential environmental, economic and developmental impact among the various alternates to reach an objective baseline for selection of the most desirable option. The methodology employed assumes that the best alternative action is the one which exhibits the least potential for adverse impact with the most frequency when compared to the other alternates.

Final selection may actually be dependent upon impacts in one or two specific areas, such as relative cost of initial development, availability of land, the potential for expensive and time-consuming litigation, or simply a consensus of the local populace or airport authority.

DEVELOPMENT OF ALTERNATIVES

The six runway alternatives were developed such that each would accommodate a 8,700' long paved Primary runway and a 7,000' long Crosswind runway (ultimate lengths), which will be capable of serving ARC C-II aircraft. Each option will also accommodate a precision approach on the Primary runway (with MALSR installation), and a straight-in nonprecision instrument approach for the Crosswind runway, with Runway Protection Zones and airport Part 77 approach protection in accordance with FAA requirements.

The options were developed with the intent of utilizing existing airport land and usable pavement to the greatest extent possible, avoiding obvious significant environmental impacts, and minimizing construction and land acquisition costs. The basic runway alignment and development criteria is as follows:

- Maximize the use of in-place pavement and base materials by development along the alignments of currently active and previous Douglas Army Airfield runways as much as possible.
- Avoid disruption of the existing airport terminal area, as well as potential terminal area expansion areas.
- Minimize environmental impacts to adjacent lands.
- Avoid any known obstructions to air navigation, including vehicular clearances over Highway 191 (old Highway 666).

The six development options are illustrated at the end of this Section (Figures 7-1 through 7-6). They are described as follows:

Development Alternative #1 Rwy 17-35 + 8-26

Alternative #1 maintains the currently active runway configuration. Runway 17-35 is maintained as the Primary runway and Runway 8-26 as the Crosswind, or secondary, runway.

Runway 17-35 (Primary) would initially be reconstructed to a length of 7,300', but would be moved to the north about 1,450' to allow future development of a Runway 17 precision instrument approach with MALSR prior to extension of the runway to its ultimate length of 8,700'. The runway would ultimately be extended to the south 1,450'. Alternately, the runway could be reconstructed in its present location, with ultimate extension to the north. However, this would dictate that runway extension would precede the precision approach and MALSR installation.

The easterly 5,850' of Runway 8-26 (Crosswind) would initially be reconstructed on its present alignment, maintaining the threshold location of Runway 26. Ultimately, this runway would be extended 1,150' to the west, for a total length of 7,000'.

Development Alternative #2 Rwy 17-35 + 3-21

Alternative #2 maintains Runway 17-35 as the Primary runway, but designates Runway 3-21 as the Crosswind runway.

The development of Runway 17-35 (Primary) would be the same as for Alternative #1.

The northeasterly 5,850' of Runway 3-21 (Crosswind) would initially

be reconstructed on its original alignment, maintaining the threshold location of Runway 21. Ultimately, this runway would be extended 1,150' to the southwest, for a total length of 7,000'.

Development Alternative #3 Rwy 3-21 + 17-35

Alternative #3 designates Runway 3-21 as the Primary runway, and Runway 17-35 as the Crosswind, or secondary, runway.

Runway 3-21 (Primary) would initially be reconstructed to a length of 7,300', maintaining the original threshold location of Runway 21. A Runway 21 precision instrument approach with MALSR would be developed in the ultimate term. The runway would ultimately be extended to the southwest 1,450', to its ultimate length of 8,700'.

The northerly 5,850' of Runway 17-35 (Crosswind) would initially be reconstructed on its original alignment, maintaining the threshold location of Runway 17. Ultimately, this runway would be extended 1,150' to the south, for a total length of 7,000'.

Development Alternative #4 Rwy 12-30 + 17-35

Alternative #4 designates Runway 12-30 as the Primary runway, and Runway 17-35 as the Crosswind runway.

Runway 12-30 (Primary) would initially be reconstructed to a length of 7,300', maintaining the original threshold location of Runway 30. A Runway 30 precision instrument approach with MALSR would be developed in the ultimate term. The runway would ultimately be extended to the northwest 1,450', to its ultimate length of 8,700'. Relocation of the present airport/prison entrance road would be required.

As with Alternative #3, the northerly 5,850' of Runway 17-35 (Crosswind) would initially be reconstructed on its original alignment, maintaining the threshold location of Runway 17. Ultimately, this runway would be extended 1,150' to the south, for a total length of 7,000'.

Development Alternative #5 Rwy 17-35 + 12-30

Alternative #5 maintains Runway 17-35 as the Primary runway, but designates Runway 12-30 as the Crosswind runway.

The development of Runway 17-35 (Primary) would be the same as for Alternative #1 and #2.

The southeasterly 5,850' of Runway 12-30 (Crosswind) would initially be reconstructed on its original alignment. The threshold of Runway 30 would be located such as to avoid relocation of the existing airport/prison entrance road (a 15' vehicular clearance is required). Ultimately, this runway would be extended 1,150' to the northwest, for a total length of 7,000'.

Development Alternative #6 Rwy 3-21 + 12-30

Alternative #6 designates Runway 3-21 as the Primary runway and Runway 12-30 as the Crosswind runway.

Runway 3-21 (Primary) would initially be reconstructed to a length of 7,300', maintaining the original threshold location of Runway 3. A Runway 21 precision instrument approach with MALSR would be developed in the ultimate term. The runway would ultimately be extended to the northeast 1,450', to its ultimate length of 8,700'.

The development of Runway 12-30 (Crosswind) would be the same as for Alternative #5.

Matrix Evaluation Methodology

In order to form a basis for selection of the most desirable option for future airport development, an objective analysis of several key factors was undertaken. These factors represent the key impact categories associated with the type of development under study, and focus on safety, utility, and economic considerations.

In the analysis, each category is evaluated independently of the others and each development alternate is assigned an "Evaluation Matrix rating" which is representative of that alternate's comparison to the other options in that specific category. A summation of all Evaluation Matrix ratings for each alternate represents the general desirability of each alternate relative to the others.

For the safety and economic related elements considered, the development alternate with the lowest total rating represents the option with the best combination of safety and economics related features. In cases where the alternates were considered equal in a specific category, both alternates were assigned the same rating (the lowest ranking remaining 1).

Safety and Economic Feasibility

The six potential development options were comparatively evaluated by consideration of several key safety and economic factors, including potential obstructions to air navigation, relative wind coverage, secondary instrument approach feasibility, and relative development costs.

Potential Obstructions to Air Navigation

The standards for determining obstructions to air navigation are found in FAR Part 77. In Subpart 77.23 of the regulations, obstructions are defined as an object (including a mobile object) which is greater than...

... a height of 500 feet above ground level at the site of the object; or

... a height that is 200 feet above ground level or above the established airport elevation (whichever is higher) within three nautical miles of the reference point of an airport which has a runway more than 3,200 feet in length. That height increases in the proportion of 100 feet for each additional nautical mile from the airport, up to a maximum of 500 feet.

Part 77 also establishes airport "imaginary surfaces", which are geometrically based upon the actual physical layout of the runways and the category of the airport's ultimate use. An object is defined as an obstruction if it would penetrate any of these imaginary surfaces.

By definition, the imaginary surfaces become increasingly critical with respect to height limitations as they become nearer to the runway surfaces, finally allowing an object height of zero within 200 feet of the runway ends.

For the purposes of this analysis, an examination of the FAA Approach surfaces within the Runway Protection Zone trapezoids for each of the alternatives was undertaken to determine the existence of any potential obstructions.

Initial layout of the various alternates was undertaken such that adequate clearance over Highway 191 would be maintained in all cases, therefore no vehicular clearance conflicts are noted. Alternative #4 would require relocation of the existing airport/prison entrance road. Alternative #5 and #6 were configured specifically to avoid relocation of the entrance road. No other apparent obstructions were found to occur, and each of the options was assumed to be equal in

this category. Each alternative was assigned an Evaluation Matrix rating of 1.

Relative Wind Coverage

Effective wind coverage is assumed to be essentially equal from a safety standpoint among the alternatives when the ultimate recommended dual-runway system is in place, since each of the combinations would exceed the recommended FAA wind coverage threshold of 95%. As a matter of fact, each of the combinations would exceed 98% coverage. For the purposes of this comparative evaluation, two factors have been considered which relate the airport's runway system to high wind conditions, as follows:

1. Wind coverage along the Primary runway has been considered, since the BDI Airport may remain a single-runway facility for some time. The runway with the best wind coverage when velocities exceed 16 knots was given the best evaluation rating.

2. Wind coverage along the proposed Crosswind runway has been considered. A separate rating has been assigned to the Crosswind runway with the best high-wind coverage.

The comparative wind analysis used the Bisbee-Douglas International Airport all-weather wind data for the period covering 1986 through 1996 (see Section 2, Inventory of Existing Conditions, pages 2-21 through 2-23). The tabulations below illustrate the results of the analysis.

Primary Runway Wind Analysis
Six Development Alternatives - Wind Over 16 knots

	Runway	Azimuth	Coverage	Rating
Alternative #1:	17-35	(359.8°)	47.87%	2
Alternative #2:	17-35	(359.8°)	47.87%	2
Alternative #3:	3-21	(044.8°)	**83.14%**	**1**
Alternative #4:	12-30	(314.8°)	37.14%	3
Alternative #5:	17-35	(359.8°)	47.87%	2
Alternative #6:	3-21	(044.8°)	**83.14%**	**1**

Crosswind Runway Wind Analysis
Six Development Alternatives - Wind Over 16 knots

	Runway	Azimuth	Coverage	Rating
Alternative #1:	8-26	(090.2°)	73.95%	2
Alternative #2:	3-21	(044.8°)	**83.14%**	**1**
Alternative #3:	17-35	(359.8°)	47.87%	3
Alternative #4:	17-35	(359.8°)	47.87%	3
Alternative #5:	12-30	(314.8°)	37.14%	4
Alternative #6:	12-30	(314.8°)	37.14%	4

Development Costs

The approximate costs for construction of the runways, taxiways, aprons, and related improvement elements have been estimated for each of the six alternative layouts. Each alternative has been ranked separately in terms of Initial development costs and Ultimate development costs. The Initial costs include construction of the 7,300' Primary runway and related improvements. The Ultimate costs reflect development of the Crosswind runway and all remaining recommended improvements. Detailed estimates tabulations are included at the end of this section.

The six alternatives have been ranked as follows:

Approximate Initial Development Costs
Six Development Alternates
Bisbee-Douglas International Airport

	Approximate Cost	Rating
Alternative #1:	$ 1,780,000	2
Alternative #2:	$ 1,780,000	2
Alternative #3:	$ 2,204,000	4
Alternative #4:	$ 1,692,000	**1**
Alternative #5:	$ 1,780,000	2
Alternative #6:	$ 1,875,500	3

Approximate Ultimate Development Costs
Six Development Alternates
Bisbee-Douglas International Airport

	Approximate Cost	Rating
Alternative #1:	$ 2,060,800	5
Alternative #2:	$ 1,972,040	3
Alternative #3:	$ 1,852,500	2
Alternative #4:	$ 1,770,000	**1**
Alternative #5:	$ 2,000,500	4
Alternative #6:	$ 2,389,000	6

The rankings above suggest that Alternative #4 is the most desirable in terms of both initial and ultimate development costs.

It is important to note, however, that the costs of development will be similar for many of the proposed alternates. The initial costs for Alternatives #1, #2 and #5 are the same. These are within $ 88,000 of Alternative #4 (about 5% difference).

Instrument Approach Procedures

Although each of the six development alternates includes the installation of a precision approach to the Primary runway, the addition of secondary nonprecision approaches will add to the safety of the airport during adverse weather conditions, and will make the airport more attractive as a pilot training center.

The United States Standard for Terminal Instrument Procedures (TERPS) specifies the standards which determine the allowable geometry for published instrument approach procedures. A straight-in approach is an approach in which the final approach course is aligned with a runway centerline. When the final approach course alignment does not meet the criteria for straight-in landing, only a circling approach may be authorized.

In general, straight-in procedures allow lower descent minimums than circling procedures because of the requirement to protect a larger area of airspace for the circling maneuvers. Visibility minimums may also be lower with a straight-in approach. These factors contribute to the utility of the runway with a straight-in procedure, making it useable more of the time in instrument conditions.

A straight-in instrument approach is also inherently safer than the circling procedure because it is a simpler procedure, with no built-in requirement to circle to the runway threshold while maintaining visual flight conditions (a pilot may also elect to circle to a runway with more favorable winds after completion of a straight-in procedure, but this maneuver is required at the conclusion of a circling approach) .

In an instrument approach to an onsite VOR, the location of the runway threshold in relationship to the VOR transmitter dictates whether a straight-in approach is allowable. Chapter 4, paragraph 413. a. (1) of the TERPS manual indicates the following :

"The angle of convergence of the final approach course and the extended runway centerline shall not exceed 30 degrees. The final approach course should be aligned to intersect the extended runway centerline 3,000 feet outward from the runway threshold."

Each of the six alternatives have been evaluated in terms of this requirement, in relationship to the location of the existing onsite DUG VORTAC.

The six alternatives use various configurations of four different runways - 17-35, 3-21, 8-26 and 12-30. It was found that in most cases, both ends of each of the proposed Primary and Crosswind runways may be served by a straight-in approach using this navaid. The exception to this is an approach to Runway 12, in which the 30 degree convergence criteria would be exceeded.

The six alternatives were evaluated and rated as follows:

Allows straight-in approach to both ends of Primary runway AND both ends of Crosswind runway . . . . . Rating = 1

Allows straight-in approach to both ends of Primary runway, BUT NOT both ends of Crosswind runway . . . . . Rating = 2

Allows straight-in approach to both ends of Crosswind runway, BUT NOT both ends of Primary runway . . . . . Rating = 3

The results of the evaluation are summarized in the following table:

POTENTIAL FOR STRAIGHT-IN INSTRUMENT APPROACHES
Six Development Alternates
Bisbee-Douglas International Airport

Alternative #1:	**1**
Alternative #2:	**1**
Alternative #3:	**1**
Alternative #4:	3
Alternative #5:	2
Alternative #6:	2

NOTE: When the FAA fully implements the Global Positioning System (GPS) as the primary air navigation system (replacing the VOR system), a straight-in approach will be possible to any runway.

Summary of Matrix Evaluation

The following tabulation is a composite summary of the results of the comparative evaluation. The total ratings achieved by each alternative in the analysis have been combined to reach a final composite evaluation rating, the lowest of which is the lowest ordinal ranking and presumably the best development option.

INITIAL EVALUATION MATRIX
Six Runway Development Alternatives
Bisbee-Douglas International Airport

	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
Obstructions to Air Navigation	**1**	**1**	**1**	**1**	**1**	**1**
Relative Wind Coverage (Primary Runway)	2	2	**1**	3	2	**1**
Relative Wind Coverage (Crosswind Runway)	2	**1**	3	3	4	4
Initial Development Costs	2	2	4	**1**	2	3
Ultimate Development Costs	5	3	2	**1**	4	6
Instrument Approaches	**1**	**1**	**1**	3	2	2
COMPOSITE RATING:	**6**	**5**	**6**	**10**	**9**	**8**
Ordinal Ranking:	2	**1**	2	5	4	3

ADDITIONAL ANALYSIS OF ALTERNATIVES: SECOND-TIER MATRIX EVALUATION

Although the Initial Matrix Evaluation suggests that Alternative #2 is the best option, it is apparent that at least two other options are ranked very closely. Alternatives #1 and #3 were rated within one point of Alternative #2.

Further evaluation of the three top-rated options was performed in order to provide a more reliable basis for determination of the best choice for development. This "Second-Tier" evaluation was accomplished as follows:

- ✔ Alternatives #4, #5, and #6 were removed from further consideration as viable development options.

- ✔ In the Second-Tier Evaluation, ratings were limited to a binary system. If an adverse impact was found when compared to the other options, a rating of "1" was assigned. If no adverse impact was found, a rating of "0" was assigned. The option with the lowest Composite Rating will be the best selection for development.

- ✔ Each remaining alternative was compared in terms of Initial Phase Development Expense. The initial development centers around reconstruction of a primary runway. Since the Runway 17-35 pavement is in the best condition, the cost of its reconstruction will be less. Alternatives #1 and #2 include Runway 17-35 as the primary runway. Alternative #3 will be more expensive in the initial phase because its primary runway is Runway 3-21, which is currently not useable.

- ✔ Each remaining alternative was compared in terms of Possible Environmental Impacts associated with construction of the future MALSR within or near an old refuse dump site. Although these impacts may be minimal, the contents of the dump are not known. Development of a precision approach to Runway 17 would place the MALSR partially within the dump. Therefore, Alternatives #1 and #2 may have potential environmental impacts. Alternative #3 would not.

- ✔ It may be important to maintain an Active Runway During Initial Phase Construction. Because of the layout of the various intersecting runways, it will not always be possible to keep the airport open during the primary runway reconstruction. With selection of Alternative #3 this is possible, since Runway 17-35

could be kept open most of the time during reconstruction of Runway 3-21. Reconstruction of Runway 17-35 (Alternatives #1 and #2) would necessitate closure of the airport during the entire construction term (it has been recommended that Runway 8-26 be closed because of its present condition).

- ✔ Each of the three alternatives was also compared in terms of potential for a 2-Runway System in the Initial Phase. With reconstruction of Runway 3-21 as the primary runway in the initial term (Alternative #3), a 2-runway system would be available. It is possible that the useful life of Runway 17-35 could be extended through the initial 5 to 10 year term, prior to its reconstruction as the crosswind runway. With selection of Alternatives #1 or #2, the BDI Airport would be a single-runway facility until the secondary runway is reconstructed.

- ✔ Each alternative was evaluated in terms of High-Wind Coverage. Examination of the wind data shows that Runway 3-21 is clearly more favorable when wind velocities exceed 15 knots. A development plan that includes this runway would be considered a safer operational environment. Alternatives #2 and #3 include development of Runway 3-21. Alternative #1 does not.

- ✔ Because of development phasing, it is important to evaluate each alternative's High-Wind Coverage in the Initial Phase. Runway 3-21 is clearly more favorable when wind velocities exceed 15 knots. Only Alternative #3 includes reconstruction of this runway in the initial phase.

The table on the following page is a summary of the Second-Tier Evaluation, which suggests that Alternative #3 is the most favorable option for development at BDI.

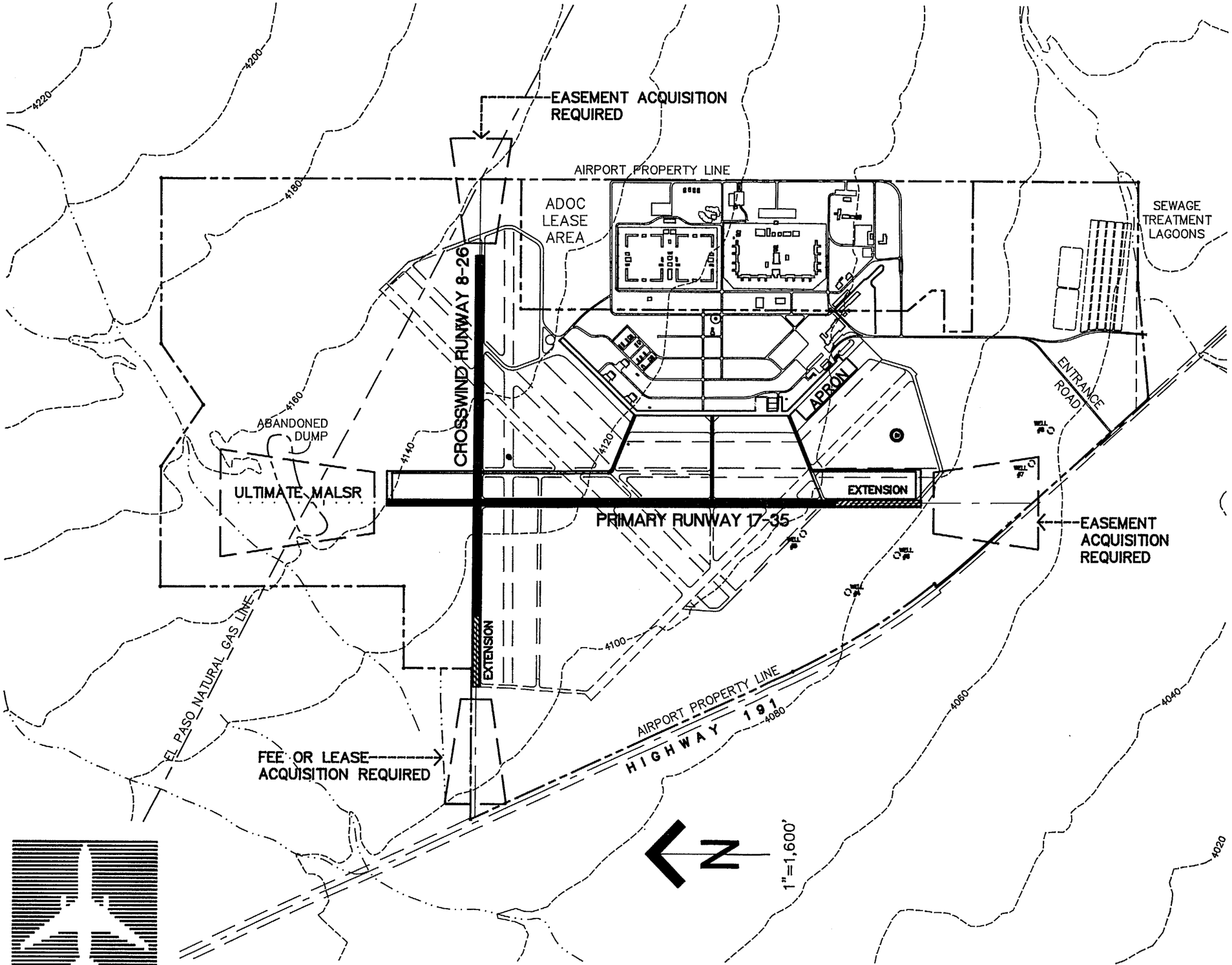
SECOND-TIER EVALUATION MATRIX
Three Highest-Ranked Initial Runway Development Alternatives
Bisbee-Douglas International Airport

	ALT 1	ALT 2	ALT 3
Initial Phase Development Expense	0	0	1
Possible Environmental Impacts (Dump)	1	1	0
Active Runway During Initial Phase Construction	1	1	0
2-Runway System in the Initial Phase	1	1	0
High-Wind Coverage	1	0	0
High-Wind Coverage in the Initial Phase	1	1	0
COMPOSITE RATING:	**5**	**4**	**1**
Ordinal Ranking:	3	2	**1**

BISBEE-DOUGLAS INTERNATIONAL AIRPORT

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

ALTERNATE NUMBER	PHASE	RUNWAY	APRON	TAXIWAYS	LAND	TOTAL
1	1	$1,245,000	$121,000	$414,000	$0	$1,780,000
	Ultimate	$1,675,000	$163,000	$119,000	$103,800	$2,060,800
Total						$3,840,800
2	1	$1,245,000	$121,000	$414,000	$0	$1,780,000
	Ultimate	$1,672,000	$163,000	$119,000	$18,040	$1,972,040
Total						$3,752,040
3	1	$1,450,000	$121,000	$435,000	$198,000	$2,204,000
	Ultimate	$1,473,000	$163,000	$200,000	$16,500	$1,852,500
Total						$4,056,500
4	1	$1,077,000	$121,000	$444,000	$0	$1,692,000
	Ultimate	$1,367,000	$163,000	$218,000	$22,000	$1,770,000
Total						$3,462,000
5	1	$1,245,000	$121,000	$414,000	$0	$1,780,000
	Ultimate	$1,661,000	$163,000	$160,000	$16,500	$2,200,500
Total						$3,780,500
6	1	$1,317,000	$121,000	$421,000	$16,500	$1,875,500
	Ultimate	$1,799,000	$163,000	$229,000	$198,000	$2,389,000
Total						$4,264,500



BISBEE-DOUGLAS INTERNATIONAL AIRPORT

PRIMARY RUNWAY: 17-35

INITIAL: 7,300' X 100'
1-MILE NONPRECISION

ULTIMATE: 8,700' X 100'
1/2-MILE PRECISION

CROSSWIND RUNWAY: 8-26

INITIAL: 5,850' X 100'
VISUAL

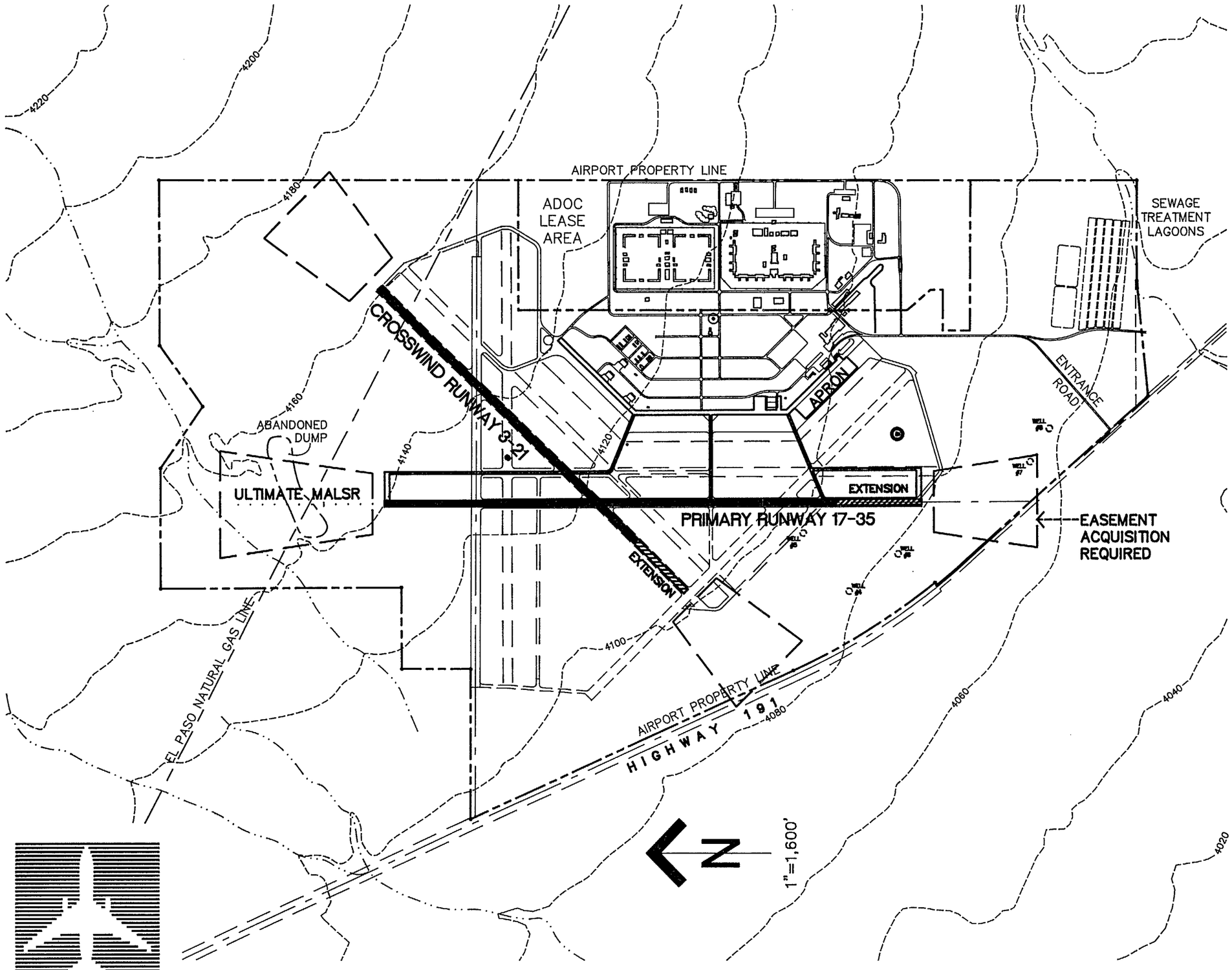
ULTIMATE: 7,000' X 100'
1-MILE NONPRECISION

PRIMARY APPROACH: 17

Development Alternative #1

February 13, 1997

Figure 7-1



BISBEE-DOUGLAS INTERNATIONAL AIRPORT

PRIMARY RUNWAY: 17-35

INITIAL: 7,300' X 100'
1-MILE NONPRECISION

ULTIMATE: 8,700' X 100'
1/2-MILE PRECISION

CROSSWIND RUNWAY: 3-21

INITIAL: 5,850' X 100'
VISUAL

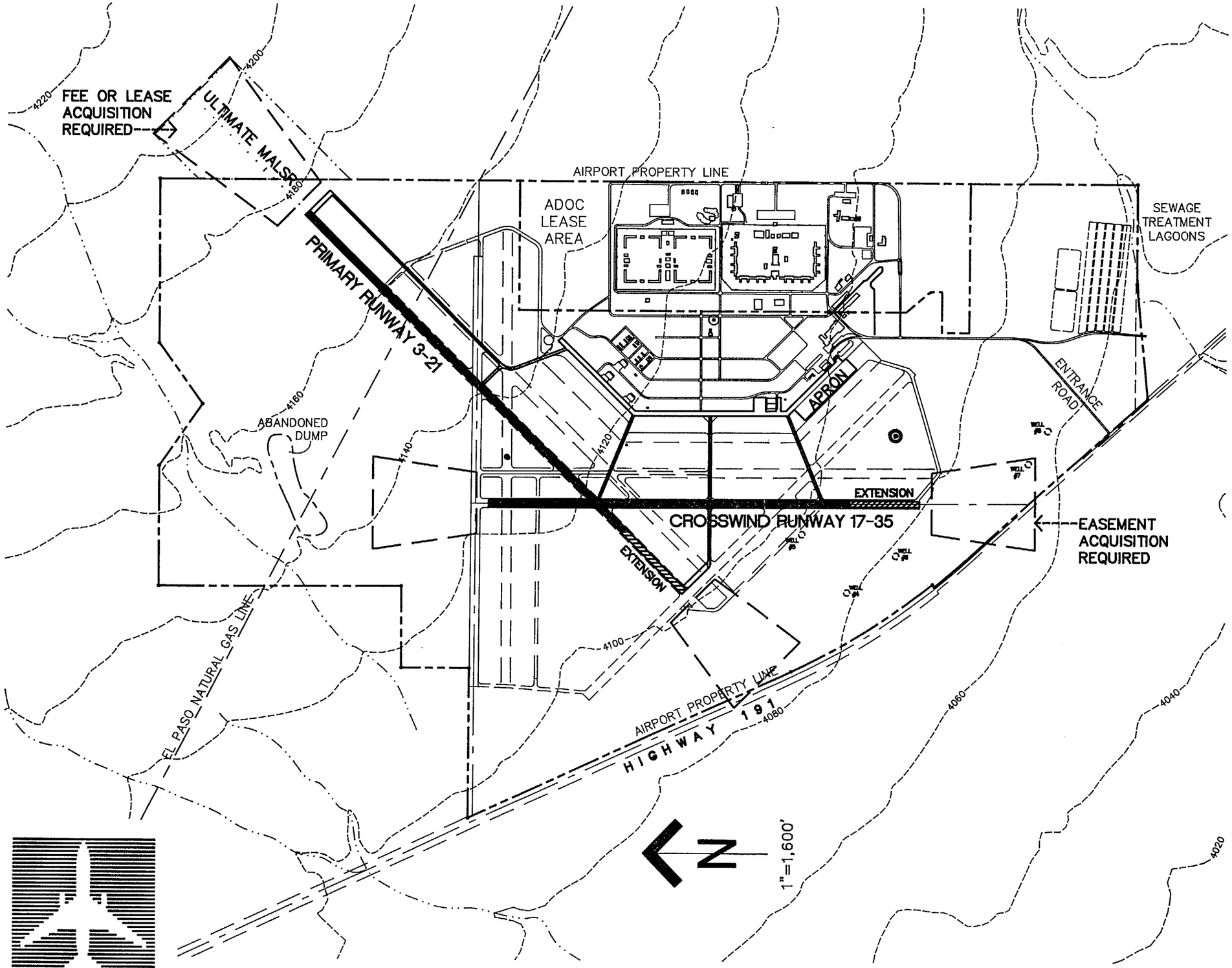
ULTIMATE: 7,000' X 100'
1-MILE NONPRECISION

PRIMARY APPROACH: 17

Development Alternative #2

Figure 7-2

February 13, 1997



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BISBEE-DOUGLAS INTERNATIONAL AIRPORT

PRIMARY RUNWAY: 3-21

INITIAL: 7,300' X 100'
1-MILE NONPRECISION

ULTIMATE: 8,700' X 100'
1/2-MILE PRECISION

CROSSWIND RUNWAY: 17-35

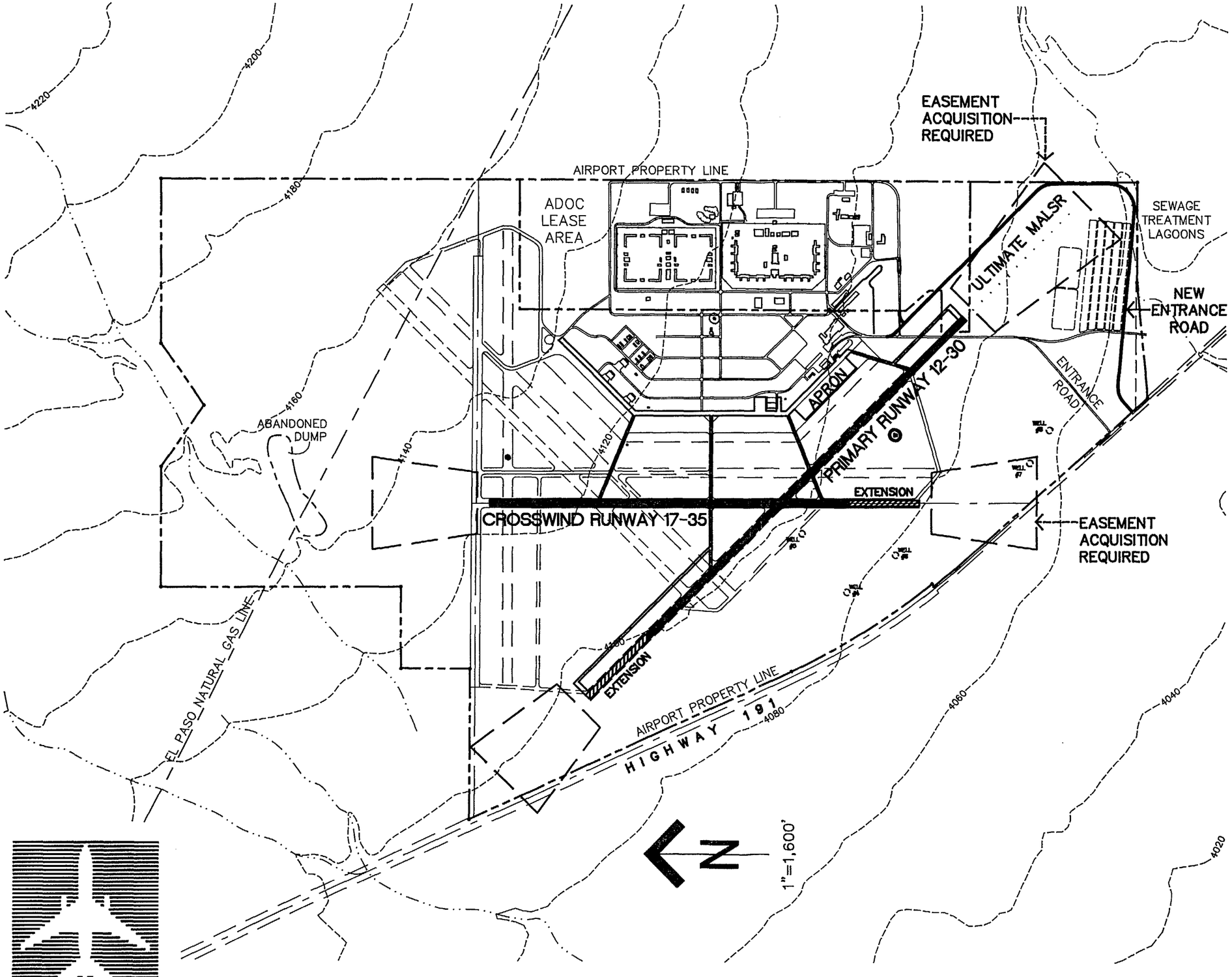
INITIAL: 5,850' X 100'
VISUAL

ULTIMATE: 7,000' X 100'
1-MILE NONPRECISION

PRIMARY APPROACH: 21

Development Alternative #3

Figure 7-3



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PRIMARY RUNWAY: 12-30

INITIAL: 7,300' X 100'
1-MILE NONPRECISION

ULTIMATE: 8,700' X 100'
1/2-MILE PRECISION

CROSSWIND RUNWAY: 17-35

INITIAL: 5,850' X 100'
VISUAL

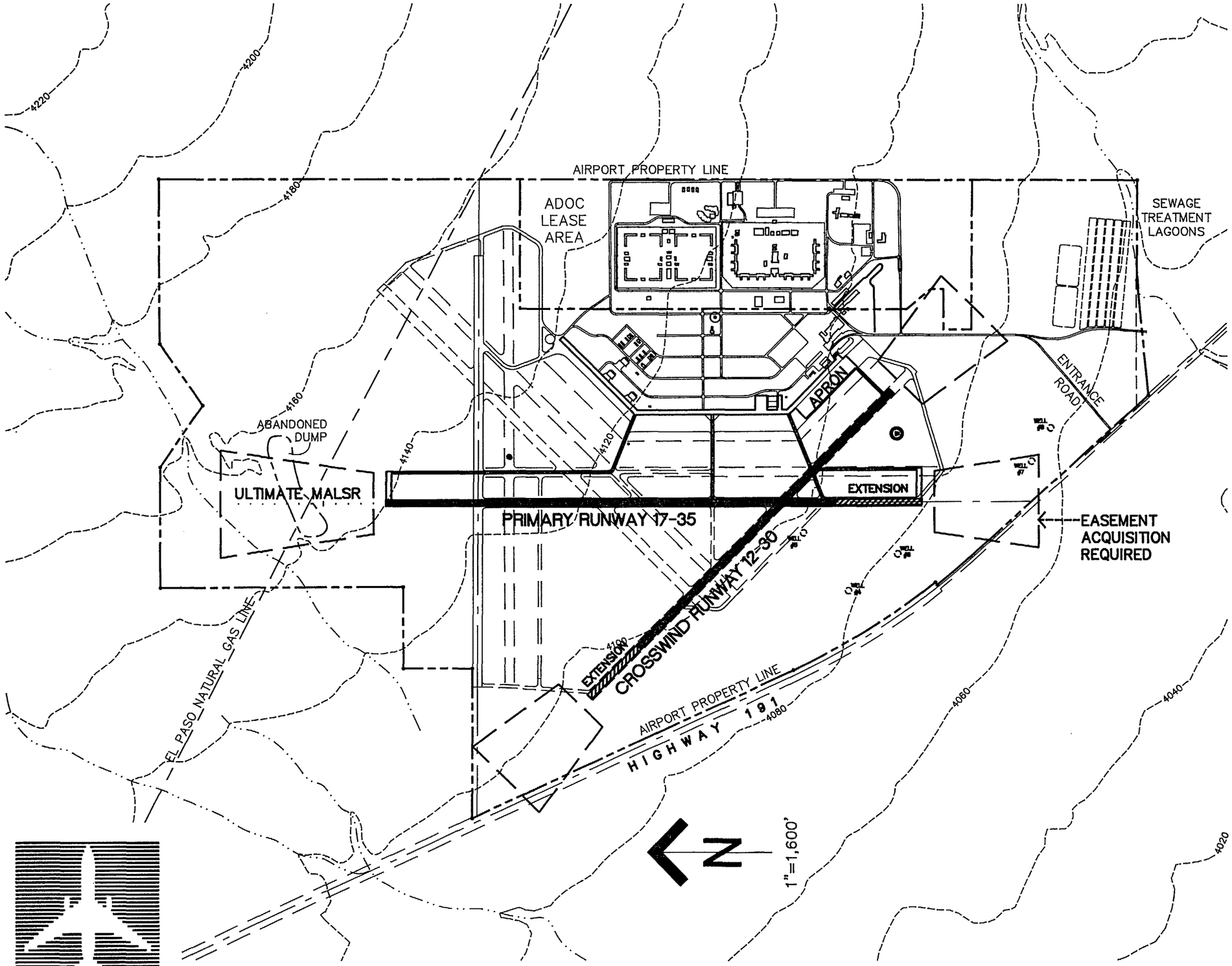
ULTIMATE: 7,000' X 100'
1-MILE NONPRECISION

PRIMARY APPROACH: 30

Development Alternative #4

February 13, 1997

Figure 7-4



BISBEE-DOUGLAS INTERNATIONAL AIRPORT

PRIMARY RUNWAY: 17-35

INITIAL: 7,300' X 100'
1-MILE NONPRECISION

ULTIMATE: 8,700' X 100'
1/2-MILE PRECISION

CROSSWIND RUNWAY: 12-30

INITIAL: 5,850' X 100'
VISUAL

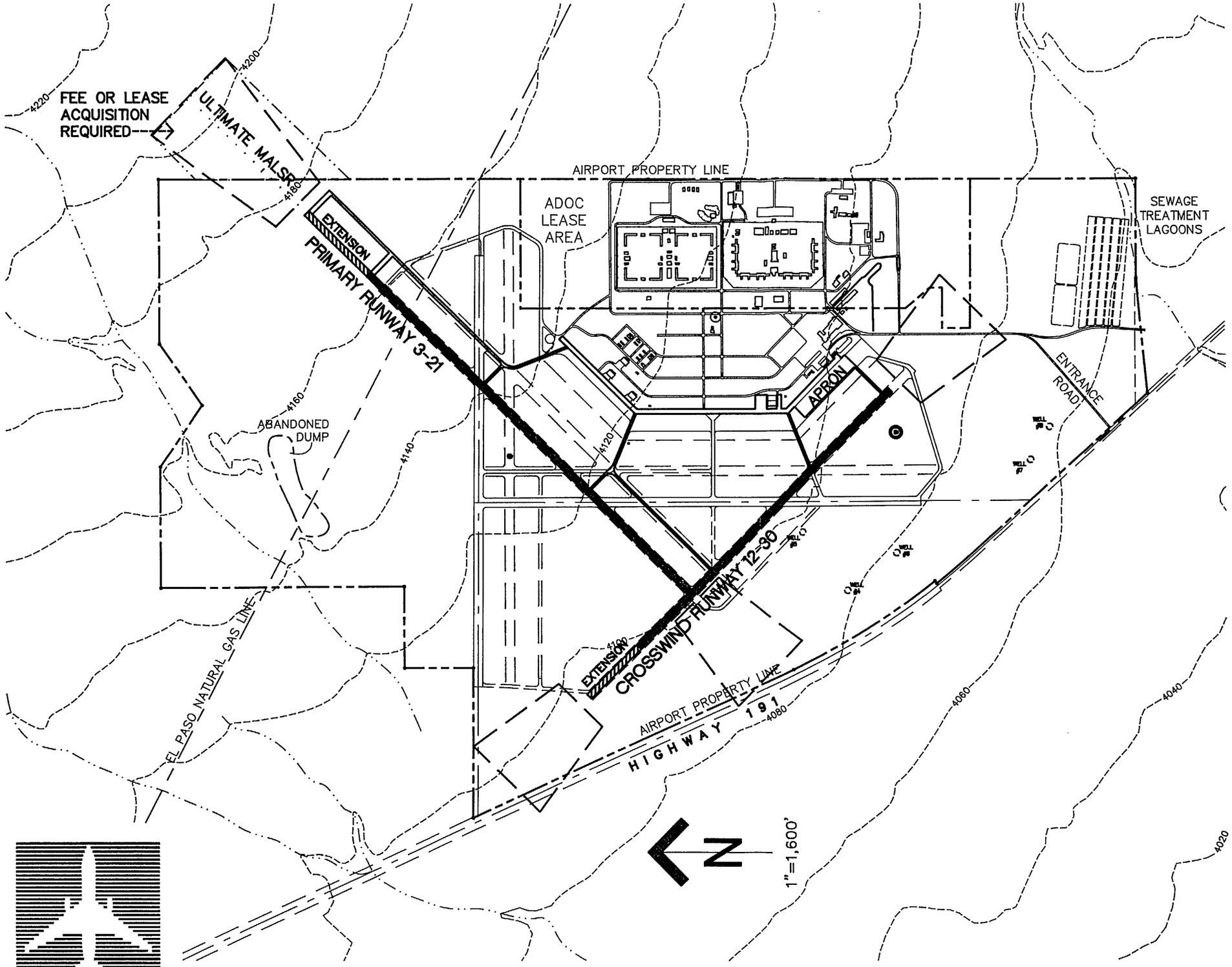
ULTIMATE: 7,000' X 100'
1-MILE NONPRECISION

PRIMARY APPROACH: 17

Development Alternative #5

Figure 7-5

February 13, 1997



March 6, 1997

BISBEE-DOUGLAS INTERNATIONAL AIRPORT

PRIMARY RUNWAY: 3-21

INITIAL: 7,300' X 100'
1-MILE NONPRECISION

ULTIMATE: 8,700' X 100'
1/2-MILE PRECISION

CROSSWIND RUNWAY: 12-30

INITIAL: 5,850' X 100'
VISUAL

ULTIMATE: 7,000' X 100'
1-MILE NONPRECISION

PRIMARY APPROACH: 21

Development Alternative #6

Figure 7-6